BC-11 (RAPID CHARGER)

BC-11 EXTERNAL VIEW

BC-11 CIRCUIT DESCRIPTION

General

The BC-11 is a rapid charger for the PB-5 to PB-9 Ni-Cd batteries for TH-25, TH-45 and TH-55.

Theory of Operation

The operation of each block is explained below.

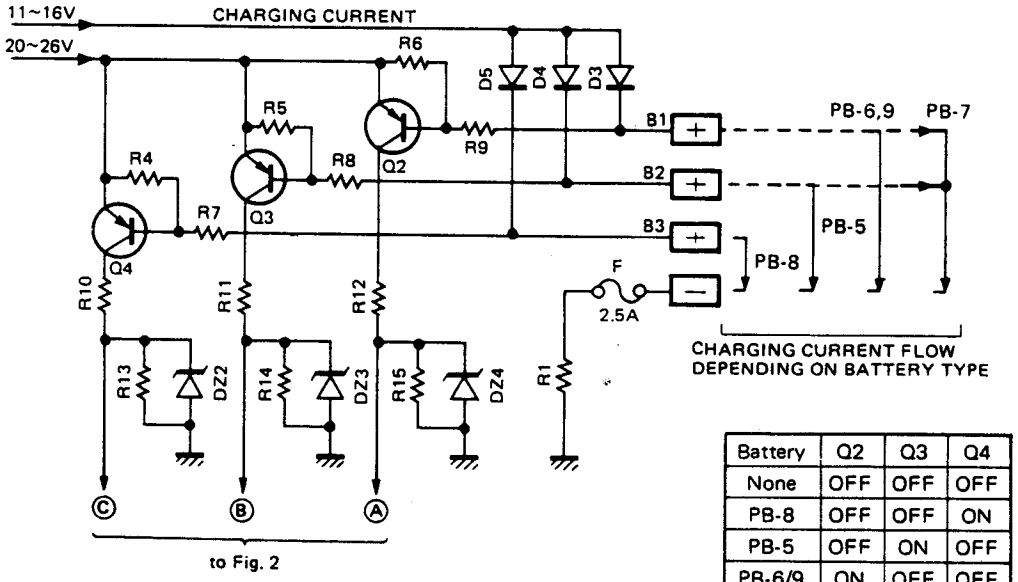
1) + 11V AVR Circuit

This AVR circuit, consisting of a 2SD600F transistor (Q1) and DZA11Y Zener diode (DZ1) provides an output of approximately + 11V as the reference voltage for the charging circuit consisting of IC2 to IC5.

2) Battery Pack Detect Circuit

This circuit detects whether a battery pack is inserted in the charger. Outputs from this circuit are routed to the reset circuit and the battery recognition circuit.

When a PB-6 or PB-9 is inserted in the charger, a small amount of current flows from Q2 : 2SA608E through R9 to the charging terminal B1 and Q2 turns on. As a result, an output of approximately 11V appears at Ⓐ in **Figure 1**. Similarly when a PB-5 or PB-7 is inserted Q3 : 2SA608E turns on and approximately 11V is provided at output Ⓑ. When a PB-8 is inserted Q4 : 2SA608E turns on and approximately 11V is provided at output Ⓒ.



Battery	Q2	Q3	Q4
None	OFF	OFF	OFF
PB-8	OFF	OFF	ON
PB-5	OFF	ON	OFF
PB-6/9	ON	OFF	OFF
PB-7	ON	ON	OFF

Table 1

Fig. 1 Battery Pack Detect Circuit Block Diagram

3) Reset Circuit/Charge Status Memory Circuit/
Display Circuit

The reset circuit initializes the charging status memory circuit.

	Q8,Q7	Q9	Q10	LED1
PACK OUT	OFF	OFF	ON	–
PACK IN				
• CHARGING	ON	ON	OFF	RED
• COMPLETE	ON	OFF	ON	GRN

Table 2

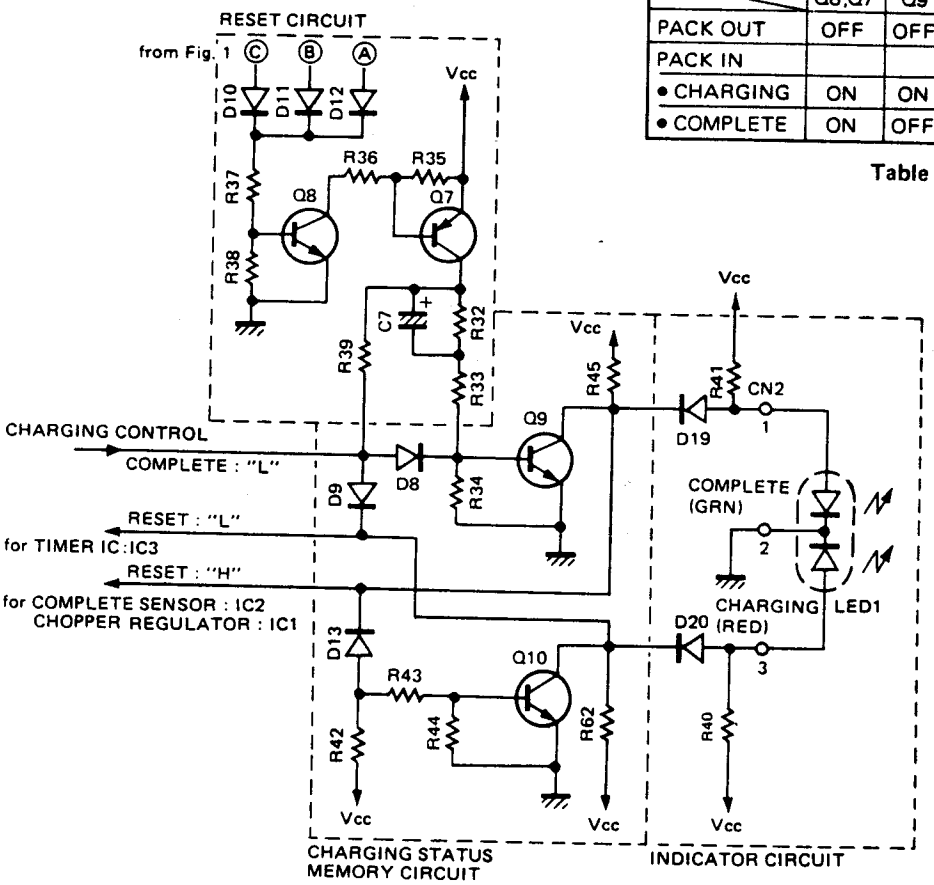


Fig. 2 Reset Circuit/Charge Status Memory Circuit/Display Circuit Block Diagram

The charge status memory circuit is an R-S flip-flop configured from transistors and resistors. The two states of the flip-flop are called COMPLETE and CHARGING. Outputs from the flip-flop drive the LED in the indicator circuit and reset the timer, complete sensor, and chopper regulator. In the COMPLETE state Q9 : 2SC536E is off and Q10 : 2SC536E is on. In the CHARGING state Q9 is on and Q10 is off.

When a battery pack is not inserted, Q8 : 2SC536E and Q7 : 2SC536E turn off. As there is no base voltage to Q9, Q9 also turns off. The base of Q10 receives enough bias from Vcc to turn on, resulting in 0V at the collector. The current flow through R41 to the COMPLETE indicator in LED1 which glows green, because of Q9 if off.

When the battery pack is inserted Q8 and Q7 turn on. As soon as Q7 turns on, charging current flows through R33, R34, and Q9 to C7 and Q9 turns on. The base voltage of Q10, which is connected to Q9 through diode D13, then drops and Q10 turns off. Since Q10 is off, current flows through R40 to the CHARGING indicator in LED1, which glows red to indicate that the battery is charging. When charging of C7 is completed, on-current continues to flow to the base of Q9 through R39 and D8.

When charging is completed the complete sensor (IC2) outputs a Low ("L")signal that ends the flow of current to the base of Q9, turning Q9 off. As a result current flows through R41 to the COMPLETE indicator in LED1, which glows green to indicate that charging is complete.

BC-11 (RAPID CHARGER)

4) Battery Recognition Circuit

The battery recognition circuit uses NAND logic to recognize the battery type from the outputs from the battery pack detect circuit. Outputs from this circuit are sent to the charging current limiting circuit and sensor level switching circuit.

	INPUT		OUTPUT		
	A	B	D	F	G
PB-5	L	H	H	H	L
PB-6	H	L	H	L	H
PB-7	H	H	L	L	H
PB-8	L	L	H	L	L
PB-9	H	L	H	L	H

Table 3

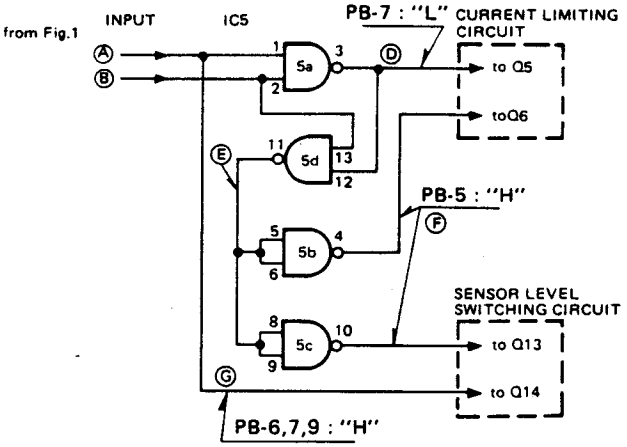


Fig. 3 Battery Recognition Circuit Block Diagram

5) Charging Current Limiting Circuit

This circuit receives the output of the battery recognition circuit and limits the charging current according to the type (current capacity) of battery. The charging current ICR is detected as a voltage drop across R1 (0.15Ω), which is provided to pin 3 of the operational amplifier IC4(1/2) : LA6393A. Pin 4 receives a reference voltage (V_{REF}) used as a comparison standard for limiting the charging current. The V_{REF} is changed by ON and OFF of Q5 and Q6 (See **Table 4**).

Pin 2 of IC4 : LA6393S provides "L" output when $V_{REF} < V_{CR}$, stopping the operation of the chopper regulator (IC1 : STK772B) and reducing the charging current. The charging current is limited by the formula :

I_{CR} MAX (A) = V_{REF} (V)/0.15(Ω)

	Q5	Q6	VREF	ICR MAX
PB-5	OFF	ON	0.15V	1.0A
PB-6	OFF	OFF	0.25V	1.7A
PB-7	ON	OFF	0.36V	2.4A
PB-8	OFF	OFF	0.25V	1.7A
PB-9	OFF	OFF	0.25V	1.7A

Table 4

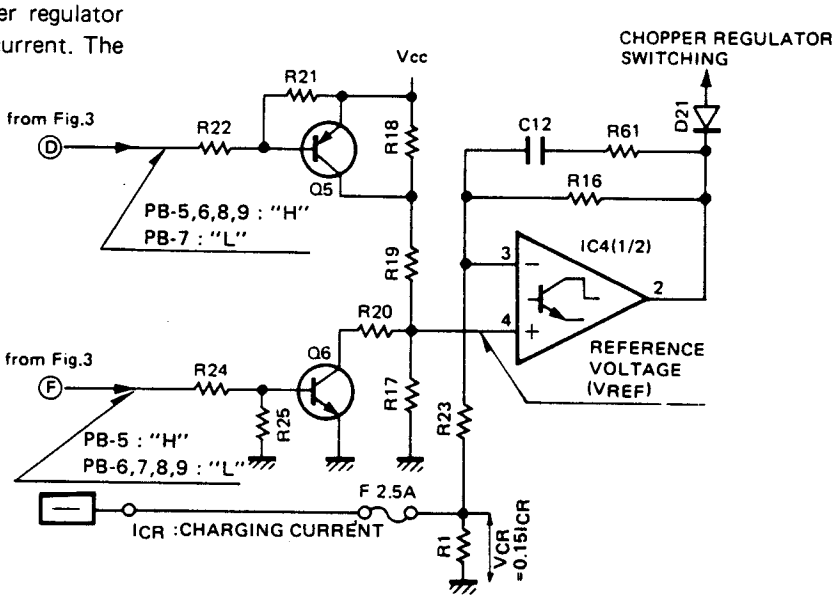


Fig. 4 Charging Current Limiting Circuit Block Diagram

BC-11 (RAPID CHARGER)

6) Sensor Level Switching Circuit

This circuit receives the output of the battery recognition circuit and aligns the voltages supplied to the charging status detect circuit according to the battery type (voltage) so that they are nearly equal at completion of charging.

	SHIFT Es(V)	Q11	Q12
PB-5	2.0	ON	OFF
PB-6	2.0	OFF	ON
PB-7	2.0	OFF	ON
PB-8	7.6	OFF	OFF
PB-9	2.0	OFF	ON

Table 5

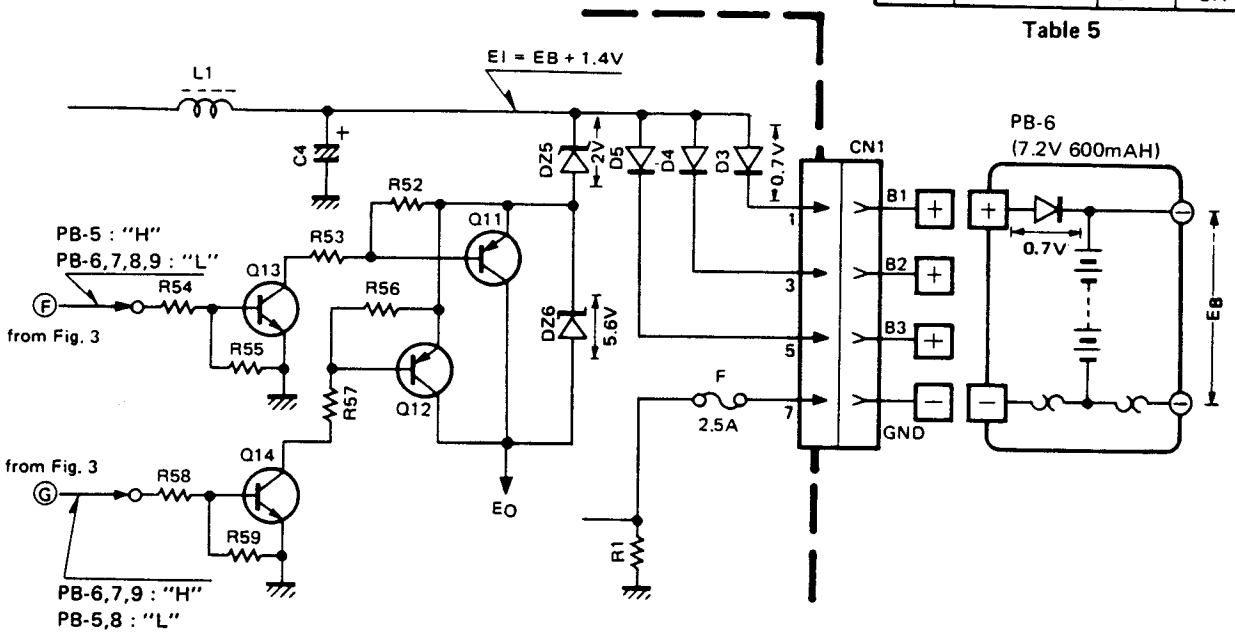


Fig. 5 Sensor Level Switching Circuit Block Diagram

The pin voltages while the Ni-Cd battery is charging are approximately 1.2 times the voltages at the completion of charging. (See **Figure 6**.)

The battery terminal voltage EB is as follows:

Approximately 14.4V for the PB-8

Approximately 8.6V for the PB-5, 6, 7, 9

The charging line voltage EI is the EB voltage plus a 1.4V voltage drop added by a diode.

EI = EB + 1.4V . . . . . (1)

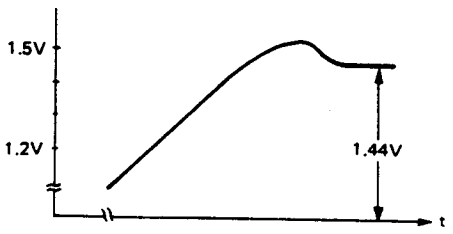


Fig. 6 The pin voltages while the Ni-CD Battery is charging

The EI voltage is output with a level shift as the voltage EO to the charging status detect circuit via Zener diode DZ6 and diodes D17 and D18. The amount of the shift is controlled by switching Q11 : 2SA608E and Q12 : 2SA608E on and off. (See **Table 5**.) If Eq. (1) is substitued into EO in **Table 5**, the results are:

PB-8 : EO = EB – 6.2V

PB-5, 6, 7, 9 : EO = EB – 0.6V

At the completion of charging the value is approximately 8V.

BC-11 (RAPID CHARGER)

7) Charging Status Detect Circuit

This circuit detects the completion of charging and outputs a signal to stop charging. When no battery pack is inserted or charging is completed, a High ("H") Reset signal is applied to D15. When a battery is inserted the Reset signal applied to D15 is cleared. When the Reset signal is cleared, pin 4 of IC2 : KCH-1003 holds the reset state due to the charge in C8 for the duration of the R46-C8 time constant, then goes "L" to clear the reset state. Pins 8 and 9 of IC2 receive divided portions of the battery voltage.
These inputs are tracked as the charging is performed in the long-term memory capacitor "MD". As the Ni-Cd battery charges, the battery voltage reaches a peak, then declines. (See **Figure 6**.) The MD stores the peak voltage, which is compared with the divided voltages at pins 8 and 9. When the difference ΔV is the same, a "L" signal is output fr. m pin 11 to indicate that charging is complete. The signal indicating completion of charging is applied to the charging status memory circuit.

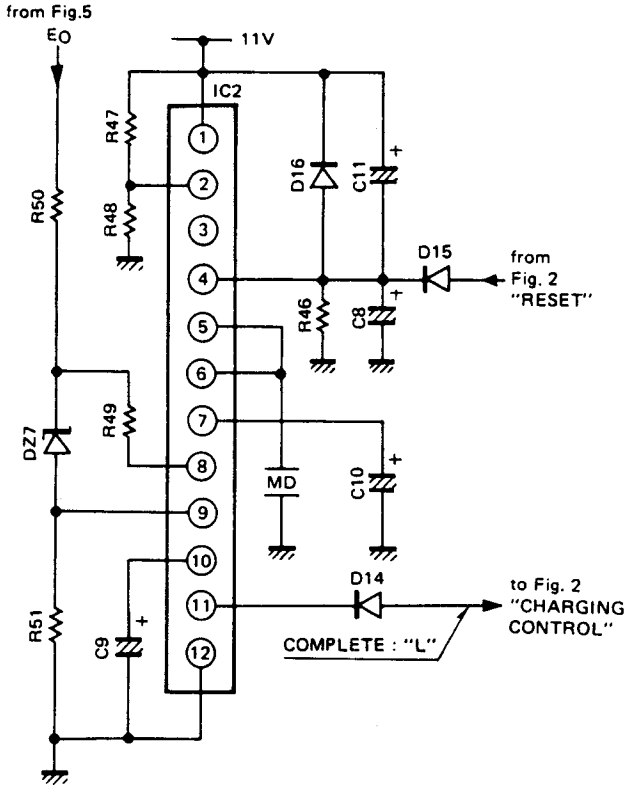


Fig. 7 Charging Status Detect Circuit Block Diagram

8) Timer Circuit

Battery defects may result in charging continuing indefinitely without completion, so this timer outputs a signal that stops charging approximately 1.7 hours after charging begins. When charging begins and the Reset signal is cleared at pin 3, IC3 : AN6780 begins counting. At the first count of 16384 pin 6 goes from "H" to "L".
The output from pin 6 is connected to the Stop input (pin 2), so the output of IC3 is held in the "L" state until IC3 receives another Reset signal (for example, when the battery is removed).

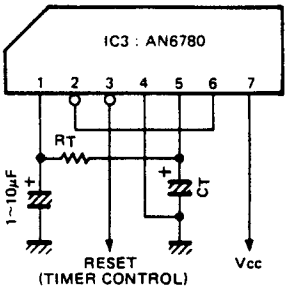


Fig. 8 Timer Circuit Block Diagram

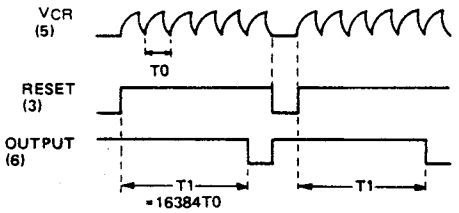


Fig. 9 TIMER TIME T1(s)≅11RT(KΩ)·CT(μF)
TIMER TIME T1(s)≅11×47(KΩ)·10(μF)=5170 (s)

9) Voltage Comparator Circuit

This circuit monitors the output (EO) of the sensor level switching circuit and indirectly detects abnormal conditions in the battery pack connected to the charging terminal. When the EO voltage falls to 5.2V or lower, the charging control line goes "L" to halt charging.

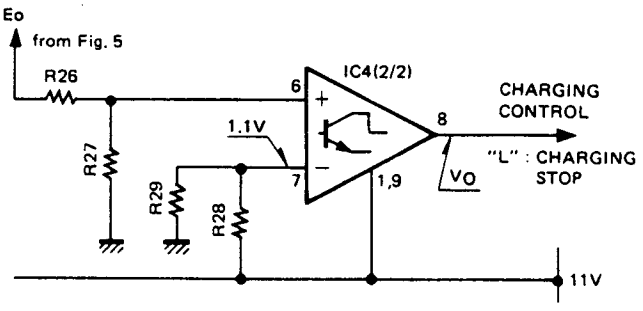


Fig. 10 Voltage Comparator Circuit Block Diagram

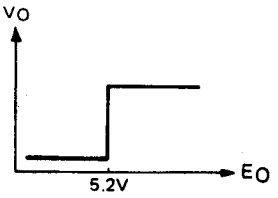


Fig. 11

BC-11 (RAPID CHARGER)

* New Parts
Parts without Parts No. are not supplied.
Les articles non mentionnes dans le Parts No. ne sont pas fournis.
Telle ohne Parts No. werden nicht geliefert.

BC-11 PARTS LIST

Ref. No. 参照番号	Address 位置	New Parts 新	Parts No. 部品番号	Description 部品名／規格	Destination 仕向	Remarks 備考
			BC-11			
1	1A	*	A02-0815-08	CASE		
2	1A,1B	*	A02-0817-08	BATTERY POCKET		
3	1B		B46-0411-00	WARRANTY CARD	K	
4	1B	*	B50-8134-08	INSTRUCTION MANUAL		
5	1B	*	E23-0604-05	TERMINAL		
⚠ 6	2A		E30-2038-08	AC CORD	K,M,M2	
⚠ 6	2A		E30-2072-08	AC CORD	W	
⚠ 6	2A		E30-2073-08	AC CORD	T	
⚠ 6	2A		E30-2095-08	AC CORD	X	
8	2B	*	H01-8128-08	ITEM CARTON CASE		
9	2B		H10-2584-02	POLYSTYRENE FOAMED FIXTURE (L)		
10	2B		H10-2585-02	POLYSTYRENE FOAMED FIXTURE (R)		
11	3A		J02-0439-05	FOOT		
12	3A		J39-0424-05	SPACER		
⚠ T1	2A		L01-8081-08	POWER TRANSFORMER (AC120V)	K,M2	
⚠ T1	2A		L01-8112-08	POWER TRANSFORMER (AC220V)	M,W	
⚠ T1	2A		L01-8122-08	POWER TRANSFORMER (AC240V)	T,X	
A	3A		N30-3006-41	MACHINE SCREW (M3 X 6)		
B	2A,1B		N34-4006-46	MACHINE SCREW (M4 X 6 TR)		
C	2A,1B		N35-4006-45	MACHINE SCREW (M4 X 6 BI) BLK		
D	2A		N87-3008-46	TAPTITE SCREW (φ3 X 8 BR)		
E	1A		N89-3008-45	TAPTITE SCREW (φ3 X 8 BI) BLK		
SW1	3A		S36-1407-05	POWER SW		
7	3B	*	W02-0399-08	CHARGE CONTROL UNIT		
			CHARGE CONTROL UNIT (W02-0399-08)			
C1			CE04EW1V222M	ELECTRO 2200μF 35WV		
C2			CE04EW1C470M	ELECTRO 47μF 16WV		
C3			CE04EW1H010M	ELECTRO 1μF 50WV		
C4			CE04EW1E471M	ELECTRO 470μF 25WV		
C5,6			CE04EW1C100M	ELECTRO 10μF 16WV		
C7			CE04EW1A101M	ELECTRO 100μF 10WV		
C8			CE04EW1C100M	ELECTRO 10μF 16WV		
C9,10			CE04EW0J101M	ELECTRO 100μF 6.3WV		
C11			CE04EW1C330M	ELECTRO 33μF 16WV		
C12			CK45B1H102K	CERAMIC 0.001μF 50WV		
C14			CE04EW1H010M	ELECTRO 1μF 50WV		

E: Scandinavia & Europe H:Audio Club K: USA P: Canada W:Europe
A: Saudi Arabia T: England U: PX(Far East, Hawaii)
UE: AAFES(Europe) X: Australia M: Other Areas

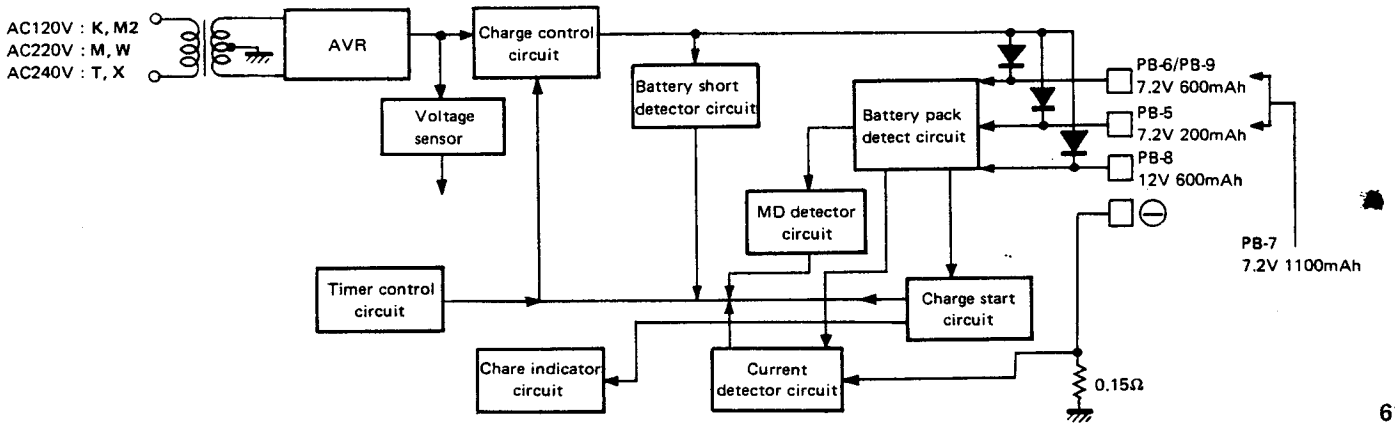
⚠ indicates safety critical components.

BC-11 (RAPID CHARGER)

* New Parts
Parts without **Parts No.** are not supplied.
Les articles non mentionnes dans le **Parts No.** ne sont pas fournis.
Teile ohne **Parts No.** werden nicht geliefert.

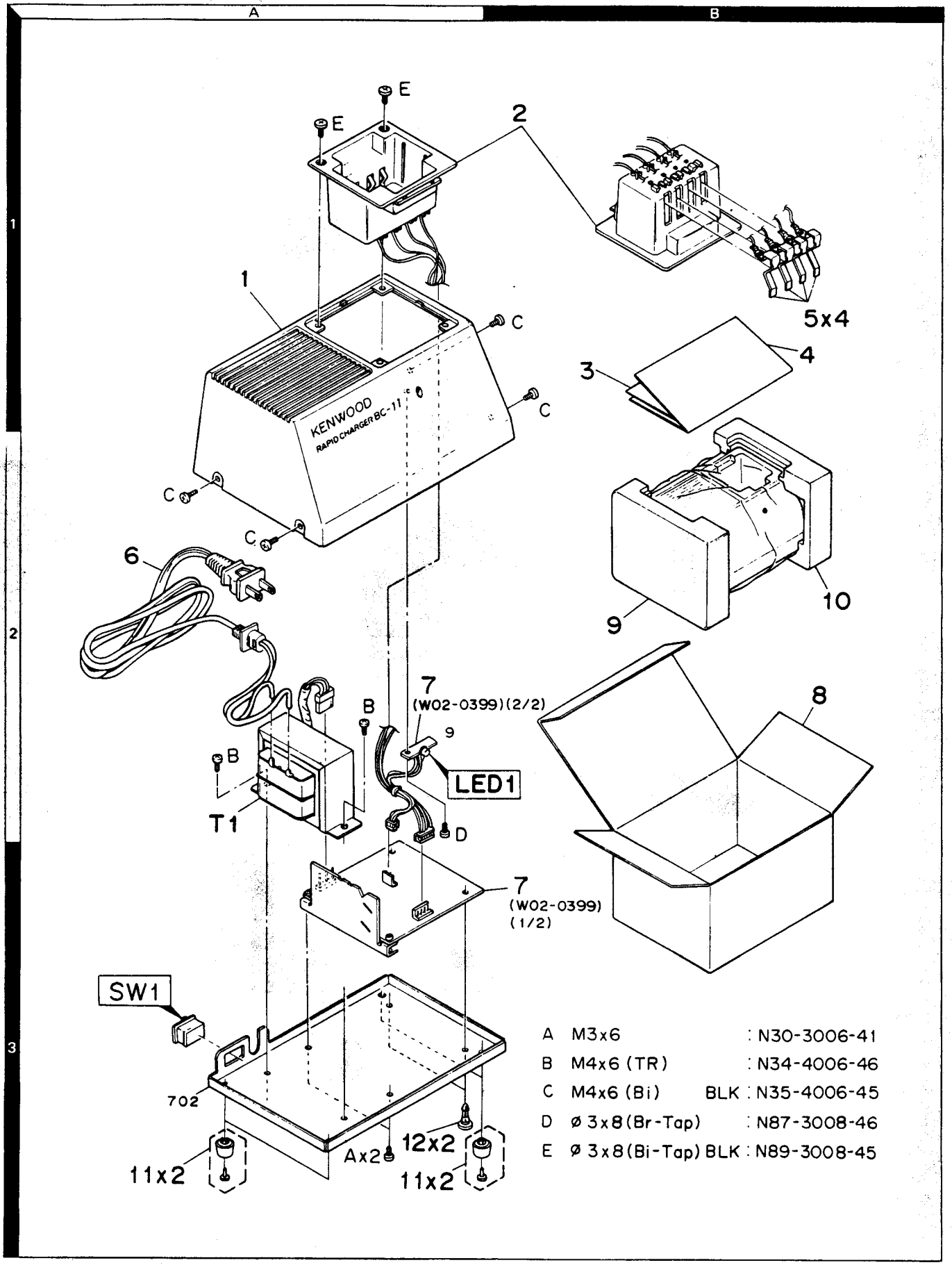
Ref. No. 参照番号	Address 位置	New Parts 新	Parts No. 部品番号	Description 部品名／規格	Destination 仕向	Remarks 備考
MD			C91-1038-08	ELECTRO		
⚠ F1			F05-2525-05	FUSE (2.5A)	W,X	
⚠ F1			F06-2522-05	FUSE (2.5A)	M,M2,T	
⚠ F1			F06-2523-05	FUSE (2.5A)	K	
–			J13-0039-05	FUSE HOLDER	W	
L1			L33-0694-08	CHOKE COIL (470μH)		
R1			R92-0683-08	FL-PROOF 0.15Ω 4W		
D1–5			DSA26B	DIODE		
D6–16			DS442	DIODE		
D19–21			DS442	DIODE		
DZ1			GZA11Y	ZENER DIODE (11V)		
DZ2–4			GZA10Z	ZENER DIODE (10V)		
DZ5			GZA2.0X	ZENER DIODE (2V)		
DZ6			GZA5.6X	ZENER DIODE (5.6V)		
DZ7			GZA7.5Y	ZENER DIODE (7.5V)		
DZ8			GZA3.0X	ZENER DIODE (3V)		
IC1			STK772B	IC (CHOPPER REGULATOR)		
IC2			KCH-1003	IC (VOLTAGE SENSOR)		
IC3			AN6780	IC (TIMER)		
IC4			LA6393S	IC (DUAL OP IC)		
IC5			LC4011B	IC (QUADRUPLE NAND GATE)		
Q1			2SD600F,KF	TRANSISTOR		
Q2–5			2SA608E,F	TRANSISTOR		
Q6			2SC536E,F	TRANSISTOR		
Q7			2SA608E,F	TRANSISTOR		
Q8–10			2SC536E,F	TRANSISTOR		
Q11,12			2SA608E,F	TRANSISTOR		
Q13,14			2SC536E,F	TRANSISTOR		
LED1	2A		SLP-540D	LED (RED/GRN)		

BC-11 BLOCK DIAGRAM



BC-11 (RAPID CHARGER)

BC-11 DISASSEMBLY/PACKING

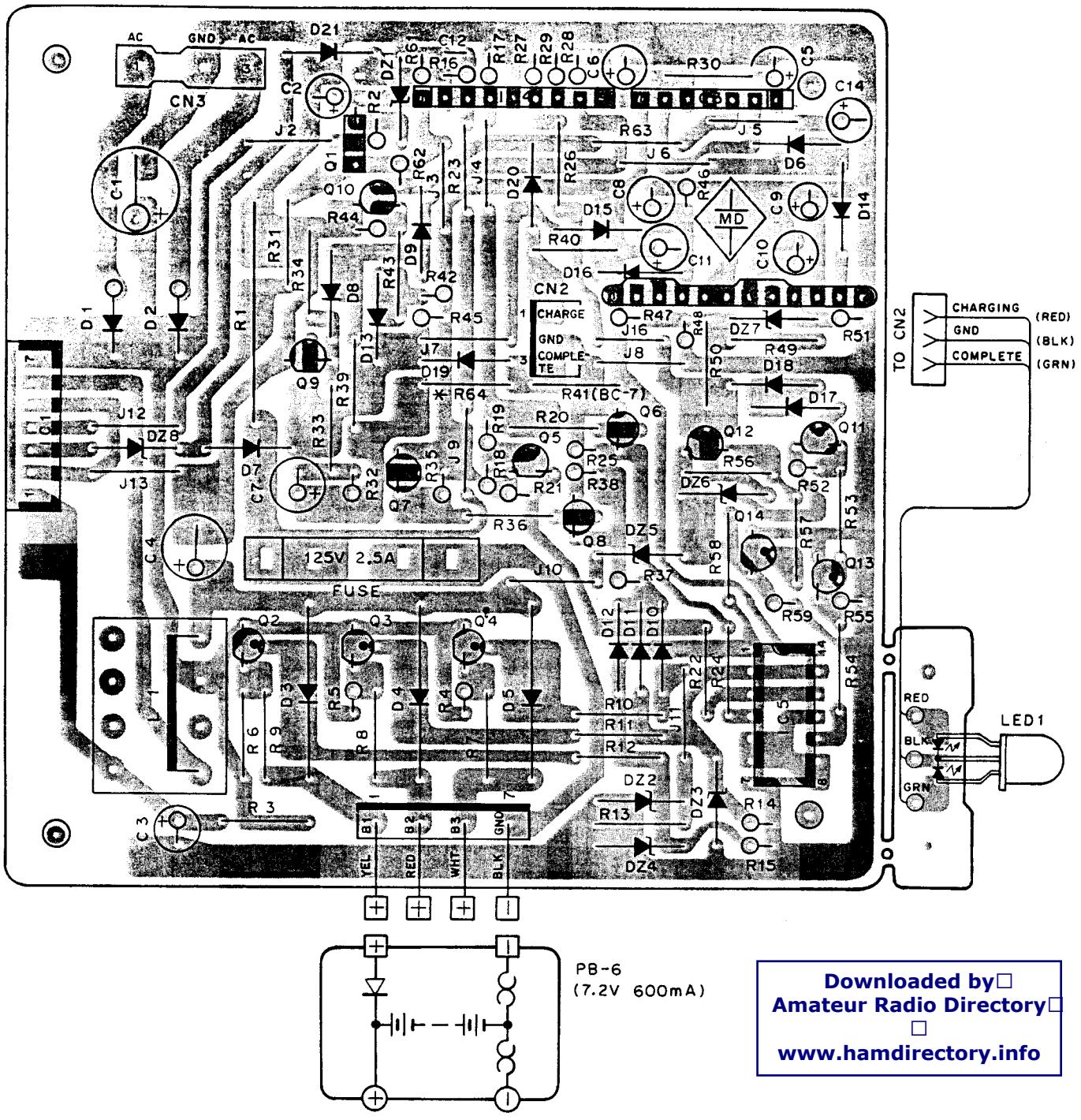


A	M3x6		: N30-3006-41
B	M4x6 (TR)		: N34-4006-46
C	M4x6 (Bi)	BLK	: N35-4006-45
D	ø 3x8 (Br-Tap)		: N87-3008-46
E	ø 3x8 (Bi-Tap)	BLK	: N89-3008-45

Parts with the exploded numbers larger than 700 are not supplied.

BC-11 (RAPID CHARGER)

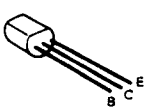
BC-11 PC BOARD VIEW



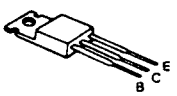
PB-6
(7.2V 600mA)

Q1 : 2SD600F,KF Q2–5,7,11,12 : 2SA608E,F Q6,8–10,13,14 : 2SC536E,F
IC1 : STK772B IC2 : KCH-1003 IC3 : AN6780 IC4 : LA6393S IC5 : LC4011B
D1–5 : DSA26B D6–16,19–21 : DS442
DZ1 : GZA11Y DZ2–4 : GZA10Z DZ5 : GZA2.0X DZ6 : GZA5.6X DZ7 : GZA7.5Y DZ8 : GZA3.0X

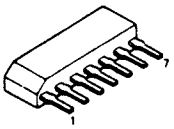
2SA608E
2SA608F



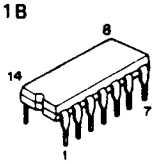
2SC536E 2SD600F
2SC536F 2SD600KF



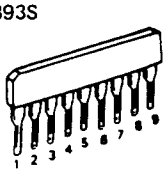
AN6780



LC4011B



LA6393S



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BC-11 CIRCUIT DIAGRAM